THE ESSENTIALS OF SOIL FERTILITY

ALVA AGEE

PRICE, FIFTY CENTS

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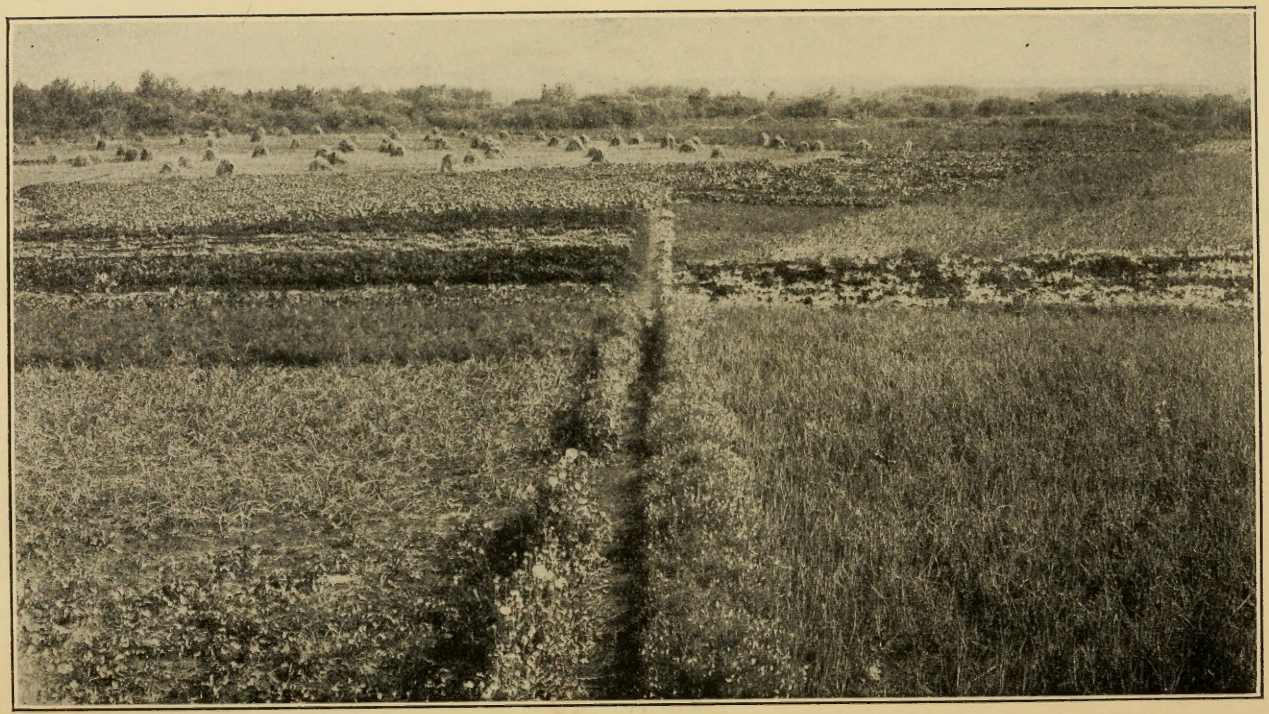

New Land Where the Soil Possesses All the Essentials of Fertility

The Essentials of Soil Fertility

BY
ALVA AGEE

"The Fertility of Our Soil Is the Salvation of Our Country"

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FOREWORD

THIS little book has been printed for practical people. It seeks to present the facts about soil fertility in such a plain and concise way that any reader may know the essential needs of his soil and the rational way of supplying those needs. It packs together into small space the teachings of The National Stockman and Farmer on soil fertility.

ALVA AGEE

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The Essentials of Soil Fertility

CHAPTER I

A PLAIN FARMER'S CREED

THEOLOGICAL experts can take the plain "Sermon on the Mount" and write so learnedly and so much that a plain citizen can't tell right from wrong in the simplest matters. Scientists can go so deep into problems of soil fertility that their results mean nothing at all to the man who has a living to make from land. Turning aside from the cart-loads of figures that are drawn out of experimental fields and laboratories each year, and from the theories of highly refined scientific minds, we know that the practical means of making land productive are simple and easily understood.

There are only four essential things to consider in converting all the thin fields between the Mississippi river and the Atlantic seaboard into productive land.

DRAINAGE

The first thing is drainage. Much of our land has natural drainage, and this problem does not enter. Other land is wet—water-soaked. We know what that means. Air cannot enter to help make the inert plant food available. Friendly bacteria cannot work for us. Plant roots will not penetrate into the stag-

nant soil. We cannot plant in season nor cultivate as we should. The soil is water-sealed when we want it to be active. Such land must have drainage.

Usually we should under-drain, and tile is the best material. But each man may solve his problem in his own way. If surface ditches will secure the end, well and good. If a deep-running plow will break up a hard-pan that prevents escape of water, that is fine. If stone drains are preferred, they can be used. If a profitable crop can be found which thrives in a rather wet soil, that is another solution to the problem. Most plants want a well-drained soil. If they are to be grown, and the land has an excess of moisture, drainage of some sort is essential. It is one of the four considerations when there is unproductive land to be put into profitable condition.

DESTRUCTION OF ACIDS

The second plain requirement is that the soil be sweet. Very much land is acid. The area grows greater year by year. The acid condition is unfavorable to many kinds of plants, and notably so in the case of the clovers. Low wet land or high sandy land may be sour. Infertile land usually is sour in the eastern half of this country. Don't waste time arguing the point with men whose land does not need lime. Let them believe as they may: no harm can result, because their soil is sweet. But lime your own land if it is acid, and do it quickly. This is the second essential, and there is no way of getting around an essential.

ORGANIC MATTER

The third factor is vegetable matter in the soil. Nature recognizes this by constant effort to produce vegetation for itself. It is the thing nature does for its old, thin, abandoned lands. Rotting vegetation helps to release inert mineral plant food in a soil. It helps physical condition, and that is important. It enables land to hold moisture, and that is a vital matter. It is plant food for another crop. Stable manure, the clovers, grass, weeds—all these supply organic matter, and this is the third essential. Anything that grows and rots helps, but some things are much better than others. Most thin fields are woefully deficient in organic matter.

AVAILABLE PLANT FOOD

We may have drainage, sweetness of soil, and organic matter, and yet lack some available plant food; and a plant must be fed just as surely as an animal must be fed. Commercial fertilizers supply this need. Some soils have no needs of any kind. Thin soils always need some available plant food—some nitrogen, phosphoric acid or potash, and usually all three until improvement is well under way. When the clovers are well established, or manure is freely used, we may be able to drop the use of commercial nitrogen. Experience will tell its own story about this.

THE RIGHT ORDER

The first matter is drainage. The next one is certainty that no acids are crippling our efforts and the efforts of the soil to help itself. The next thing is to

supply stable manure or decaying plant roots and stubble—heavy sods or other growth of vegetation. Then we can have good physical condition and ability to hold moisture during drought. The rotting vegetation makes available a part of the old, inert stores of material in what was a worthless soil. Then we only supplement the supply of fertility, as needed, by the use of commercial fertilizers.

THE DIFFERENCE

Of course good tillage is needed—that goes without saying. So is good seed, and many other things. But the difference between the hundreds of thousands of acres of poor land and the good land is one embracing only the four essentials mentioned, and often only three or two of them. The land can be taken out of the nearly worthless class and put into the productive class by intelligent supply of the one, two, three or four things that chance to be needed. The problem is not an intricate one. Thousands of men have solved it for themselves, and they did it in this way, because it is *the one way.* When a soil has a need, it can not be fooled into believing all is well till the need has been supplied.

THE BIG PROBLEM

Some scientists may say, with a fine conservatism, that we do not know that there is any soil acidity, any actual soil exhaustion, any direct need of the plant food in a fertilizer. What of it! The owner of land has a living to make, and all he has to do is to brush aside the cobwebs of the ultra-scientific soul

and make the soil productive. The factors are four in number, and he may have to supply all, or only one, two, or three. The land must have drainage, freedom from acids, organic matter and plenty of available plant food. Then it will produce, despite all theories.

The big problem is to do what is needed in the most profitable way. What will pay? That is the question. If land must be cropped, it will pay to provide the four essentials, if all four are lacking. Is it drainage? How much and in what way shall we drain? Is it soil acidity? When and how heavily shall we lime? Is it organic matter? How can we get it to best advantage? That involves crop rotations, the making of manure, the use of sods and green manures, etc., etc. Is it available plant food that we must have? What proportion and what amounts of the elements of plant food will pay best? The problem is one of best means, but we know what we are after: drainage, sweet soil conditions, organic matter and plant food.

CHAPTER II

THE FIRST ESSENTIAL

DRAINAGE OF WET LAND

Wet land cannot earn the money needed for investment in its own improvement. A soil having natural drainage may be thin, but under good management it can grow better, helping the owner to the means for its betterment. Wet land is helpless. The money to put it into paying condition must come from the outside. There is the difficulty—the big obstacle. I don't like to urge under drainage as insistently as I would urge the growing of vegetable matter for thin soils; because the drainage, on any large scale, means a new investment, often equal to half the selling price of the land. It means debt to the man whose income has been solely from a wet farm. Thorough under-drainage is a big proposition.

I know the cost of under-drainage, because I have put miles of it in land so heavy and wet that laterals could not be placed farther apart than 32 to 40 feet. Equally I know the profit on such investment, the drainage changing land that could not earn any net profit into land that could earn the entire cost of drainage in a single season. In two or three fields it did more than this. An investment of twenty to thirty dollars an acre for improvement cannot be made on some land with safety, and it seems prohibitive to most owners of wet farms, but there is a

A Typical Crop of Ohio Corn

Oats and Peas—A Good Forage That Enriches the Soil

Forty Bushels of Wheat Per Acre—The Result of Drainage and Fertility

It Pays to Provide the Proper Fertilizer for Hay

rational way of attacking this problem of drainage that most men can adopt with safety and profit.

BEGINNING TO DRAIN

Any farmer could and would invest a small sum in drainage if he knew the cost would be repaid quickly. If he has a fairly productive field containing a few wet acres that delay plowing and planting of the whole field each year, and that cut down the yield of the whole field, there is the place to make the first investment. Make that wet part of the field the driest part and the most productive part by means of drainage, and see how quickly the money returns. The experiment gives practical experience in under-drainage, cash returns and plenty of faith to push the work of continued under-drainage. Be content to try the matter out on a few acres and know for yourself what drainage can do in increasing yields per acre. Then you will begin to drain more land because you know you can not afford to let it remain wet.

THE FIRST THING TO DO

Many farms remain wet and unproductive because their owners do not know anything about drain tile and the right way to do the work. The whole matter looks difficult. But it is not. Plain common sense dictates everything that is necessary to do in underdraining land. The first thing is to learn how good drain tile can be delivered to the farm for the least money. Write to manufacturers and dealers. Acquaint yourself with prices at the factories for the

various sizes. Learn about freight rates in car lots. A few letters will let you know the best price on each size that may be used, and a measuring tape will let you know how much tile you propose using in this first undertaking. Lack of this kind of knowledge stands in the way of many a beginning that would end in much net profit.

THE OUTLET

Water wants to run down hill. The outlet is the first point to locate. If the land is flat, use a surveyor's level. Don't trust the eye nor any present impression that the water can be carried in one direction as easily as in another. A level usually surprises one about the fall. Try for an outlet that will never give any trouble. Under-drainage should remain about as permanent and enduring as the land itself, and that means an outlet which attends to its work. But it is better to drain into a ditch that requires watching than not to under-drain at all.

The outlet must be lower than any point in the drain. Water from above will force itself through a depression in a drain for a time, but soon the depression fills with silt, and the drain is clogged. Every foot of pipe must have ability to send the water on toward the outlet.

THE GRADE

If the land is flat, have the grade established by an engineer's level. Don't trust a mason's level and your eye. They may be all right when there is a lot of fall —a foot or more to each one hundred feet—but worth-

less when the fall is slight. Drive a stake flush with surface of ground at each one hundred foot station in the lines of the proposed main drain and all the laterals. Get the levels of these stations. Then you can know the depth of cut at each station to give the grade wanted. A fall of three inches to each one hundred feet is excellent. I like it all the better when the fall is more, but have laid much tile where the fall is less. One big main went in with a fall of less than an inch to the hundred feet. The only requirement for enduring work is that the tile between stations goes in on a practically perfect grade, and that is not difficult if a system of cross strings is used to test each foot of the drain between stations.

DEPTH OF UNDER-DRAINAGE

We under-drain to lower the level of the dead water in the ground. Plant roots cannot develop where the pores of the soil are filled with stagnant water. The soil is the feeding-ground of plants, and air is an absolute requirement. The water which best serves plants is held in films around the tiny particles of soil, and drainage must be provided for naturally wet land to remove any surplus. The depth at which under-drains work effectively determines the amount of soil in which plants may feed to best advantage. If the ground is of such character that it will become reasonably porous after under-drainage, it is desirable that the drains be at least three feet under the surface. Experience has shown that much heavy land will not permit the water from trenches to descend sufficiently rapidly to drains three feet deep, and the owner of such land is

cautioned on this point. A depth of 30 inches is safer for all land of close texture, and there are relatively small areas of very plastic soils in which drain tile should not be buried more than 24 to 28 inches.

LAYING THE TILE

Have the main a few inches lower than all laterals, so that the water from the laterals will be drawn into the main. You can buy tile with holes cut for connection with laterals. Take pains to have the connection close. Don't leave any places for water to enter freely from the soil above the connection. This applies equally to every joint in the drain. When laying tile, turn the piece around until it fits snugly at the top. We want all the water to settle in the soil and rise into the tile. That reduces the amount of silt entering the drain. Don't fear the joint will be too close. Pressure will send the water through the closest joint that can be made. Fill the trench with earth. The water will find the tile without aid of straw, sods or stone placed over the tile. In most soils they may do harm and not good. The only exception to this rule is a very plastic clay that will remain nearly impervious to water. In such a case, it is best to keep the soil above the drain open by means of foreign material.

SIZE OF TILE

As size of tile increases, cost runs up fast. We do not want to waste money, and, on the other hand, a main that will not carry off the water in time to save a crop is worthless. A main should be large enough

to carry all the water that the owner may ever want to bring to it by extension of his system of drainage. The area to be drained, the thoroughness of the drainage, and the amount of surface water coming from higher land that is undrained, determine the size of the main. The fall also is a factor. Ordinarily, I should expect a six-inch main to carry all the water from a twelve-acre field, or a five-inch main to carry the water from an eight-acre field, if no surface water from other land ran down upon it. I should not use tile less than five inches for a main if there were many laterals to be joined to it.

The laterals should be small. They cost much less and do the work perfectly when put into position in a workmanlike manner. Many factories now make nothing less than three inches in diameter. This indicates that people do not like to trust a smaller size. Formerly they used two-inch, and carelessness in laying, causing depressions that finally filled with silt, brought this size into disrepute. I have seldom used anything larger than two-and-a-half inch tile for laterals. Certainly the three-inch is abundantly large.

CHAPTER III

THE SECOND ESSENTIAL

THE RIGHT USE OF LIME

Lime may be applied to the soil to improve its physical condition, and there are instances in which it is needed as actual plant food; but I am chiefly interested in lime as a means of keeping a soil friendly to plant life through correction of acidity. The tendency of all soils is to lose some of their stock of available lime, and, when a lime deficiency comes about, acids accumulate in the soil that make conditions unfriendly to bacterial life and to our cultivated plants. A large portion of the land outside of limestone belts has parted with its available lime to a point where a lime deficiency now exists, and this condition is limiting the production of clover and other crops. More than this, within our limestone belts there is a rapidly increasing area of soil which has a lime deficiency. I live in a limestone valley at State College, Pennsylvania, and our scientists find that much of the land on the College farm does not now contain enough lime in available form to keep the soil sweet. The land is becoming acid, and requires applications of lime to correct acidity just as truly as does very much of the land outside of the limestone areas. When we first began to turn new land with a breaking-plow, doubtless a diminution of the supplies of available lime occurred, and, as the soil

was kept loose by means of tillage and crops were taken from the land, the store of lime was gradually reduced by leaching and by removal and by chemical change as acids formed, and it appears now that it is only a matter of time when practically all soil will reach a point where a lack of available lime will become apparent. Some of you have land that produced good clover twenty years ago and is now beginning to refuse to grow clover. Others of you have land that is producing good clover today, but will probably reach the point of lime deficiency and impaired power to grow clover a generation hence. The point which I would emphasize is that the lime in our soil which is so essential to healthful plant conditions tends to grow less in amount as the years go by. Within our own life-time, we have seen a large proportion of our tillable lands reach the point where there is not enough lime to take care of harmful soil acids, and as the years come the area of such land will grow greater. This is not a pleasing situation to contemplate, but it is a condition that must be met. There is only one cure for soil acidity, and that is to apply something to correct it and to give to the plants friendly soil conditions.

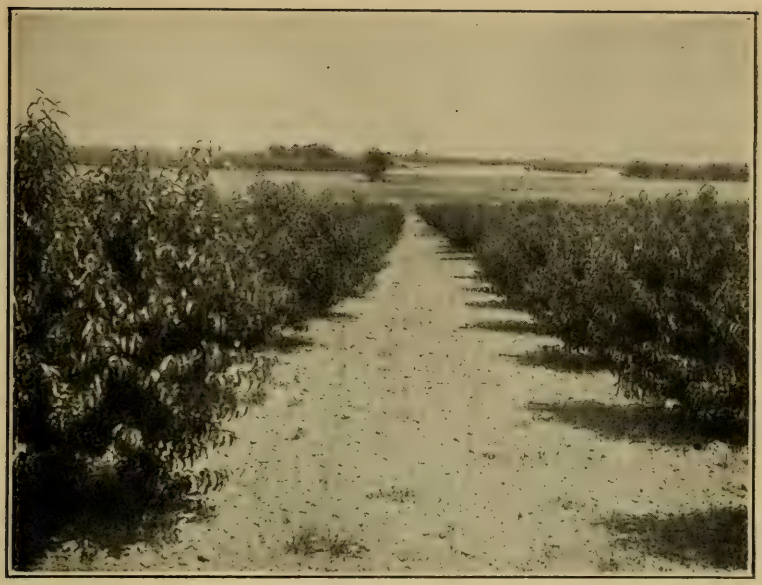
SWEETEN THE SOIL

The vital question before tens of thousands of practical farmers today is, what shall be done to restore their soils to a condition friendly to clovers. Many say that lime costs too much and that its application is unpleasant, and they are not fully convinced that it would be profitable. I want to urge

that if the soil is becoming acid, and if the organic matter is deficient because heavy sods cannot be grown and plowed down, there is no way to bring the land up to high-cropping power except to apply the one natural element for the correction of these bad soil conditions, and that is lime. Men who abused the use of lime years ago applied one hundred to two hundred bushels per acre. It is not such a liming that we are urging today. I am not even urging lime to benefit the physical condition of your land, although oftentimes applications for this purpose would pay well; but I am urging that soils be kept sweet, and that means the presence of sufficient available lime to take care of all the harmful acids that tend continually to accumulate in land that is deficient in lime.

HOW MUCH LIME?

The only way to tell how much lime should be applied is try out the matter through experiment. If your land today refuses to grow clover, the chances are that you will see a wonderful difference in the growth if only a thousand pounds of lime per acre be applied. I know land that has greatly increased its clover production by the application of only five hundred pounds per acre. In a general way, if clovers are refusing to grow or if general conditions are unfavorable to other sods, one should apply a thousand pounds per acre. If the land is decidedly acid, and lime not excessively high in price, he will do well to use one ton of lime per acre. I mean one ton of lump lime or its equivalent in slaked lime or pulverized limestone.



Young Peach Orchard

Small Fruits for the Farm Home

Crimson Clover Adds Fertility to the Soil

Rape Is a Succulent Forage

WHAT FORM?

Many farmers are asking what form of lime they should use. The correct answer depends upon the cost of the material. Pulverized lime, which is limestone burned into lime, and then made mechanically fine in order that it may be distributed with ease, contains the greatest possible amount of material for correcting soil acidity. When lime has been slaked with water, its weight has been increased, while its ability to correct acidity has not been increased. One ton of lump lime will correct about as much acidity, roughly speaking, as two tons of finely pulverized limestone. If the limestone could be made as fine as flour, so that every particle were available in the soil, two tons of the limestone would correct somewhat more acidity than one ton of lime, but, as we find the pulverized limestone on the market, it is safe to say that it is not fine enough to permit two tons to be as effective as one ton of the pulverized lime. The so-called "new process" lime on the market is a lime which has been slaked by steam, and therefore has had its weight increased without any addition of ability to correct acidity. One ton of this "new-process" lime cannot correct as much soil acidity as one ton of pulverized lime. On the other hand, the ease of application is a great consideration. "New-process" lime is easy to handle, and on that account may be worth as much to the farmer as the pulverized lime which is unslaked and must be drilled into the ground before it slakes, unless one is willing to be troubled by burst packages.

Pulverized limestone can be handled with compara-

tive ease; but the buyer must remember that he is paying for the transportation of a large amount of waste material in the pulverized limestone, as nearly one-half of it is worthless so far as correction of acidity is concerned. It is a mere matter of arithmetic to determine how much soil acidity can be corrected with the least amount of money, the first cost of material and the transportation and the ease of application being considered.

HOW SHOULD LIME BE APPLIED?

When the general need of lime is more fully appreciated, there will be a greater demand for lime spreaders. Several firms are making spreaders that handle lime in small quantities per acre. Where lime is inexpensive and the farmer can afford to apply forty or fifty bushels per acre, he will find that the manure spreader will do fairly even work; but when lime is costly and only one thousand pounds per acre should be applied, the manure spreader is not satisfactory. The Ohio Experiment Station had a lime spreader made at a local blacksmith shop at a total cost of seventeen dollars. A V-shaped box was used with an axle passing through the box and furnishing a fairly good force feed. Old mower wheels were used for this spreader, and it gave good satisfaction. Some grain drills with fertilizer attachments are capable of applying five hundred to one thousand pounds of lime per acre, but I think most men fail to get such results from their drills, and the thing to do is to purchase lime spreaders that will apply any amount from a few hundred pounds to a ton or two per acre.

The easiest way to make lime applications is none too good.

DO NOT PLOW DOWN

Lime should not be plowed down. The old way was to apply one to two hundred bushels of lime per acre on the sod and to let it lie for months and then plow it down. In the case of such heavy applications, the more waste the better for the land; but when lime costs several dollars a ton the right way is to get the greatest possible effectiveness out of it, and that means working the lime into the surface of the soil after the land has been broken for the crop. The tendency of lime always is downward. Do not plow lime down, but bring it into contact with the free acid in the top soil. Let it become mixed with the top soil and make it sweet.

HOW TO VIEW LIMING

We often are asked whether lime will increase the yield of corn and wheat and other crops. If land is sour, containing harmful acid, the sweetening of that land with lime will result in increased yield of almost any staple product, but we do not urge any one to apply lime for the sake of increase in yield of corn, wheat and similar crops. We wish the farmer to take a different view-point. If his land is in an unhealthy state and lime will put it into a condition friendly to plants, the thing to do is to correct that soil with lime and, when that has been done, he should have in mind first the production of a heavy clover sod. The increase in yield of wheat or corn is incidental. The vital thing is to make the land

friendly to all plants, especially clover, because in most farm crop rotations clover is fundamental, and continued productiveness of the soil depends largely upon it. As clover usually is seeded either with oats or wheat, the lime may be drilled into the ground while preparing the seed bed for oats or for wheat. If the farmer prefers, he can drill the lime into the ground when preparing land for corn, although I am sure that a larger amount per acre will be necessary than when applying the lime immediately previous to the seeding to clover.

I have tried to impress these facts: The tendency of soils is toward lime deficiency. Limestone soils themselves gradually lose some available lime. Maximum crops can be obtained only from neutral or alkaline soils. As lands grow old, we shall be compelled to apply more and more lime to keep the soil sweet, and we can get that lime out of stone lime, pulverized or slaked lime or finely pulverized limestone. The day will come when we will realize that the Creator placed beds of limestone in our lands for the benefit of humanity, just as He placed the coal beds. Just as the coal is an accumulation of material for the benefit of the human race, so is our limestone an accumulation of material to satisfy deficiencies that will continue more and more to occur in our tillable soils as long as the earth stands. If there were no supplies of lime, we probably could look forward only to the day when our soils would be rank with poisonous acids and wholly unfriendly to plant life.

CHAPTER IV

THE THIRD ESSENTIAL

ORGANIC MATTER

When land has been robbed through the greed of its owner and has been abandoned, nature immediately begins the work of restoration. All land which once was in productive condition contains large stores of inert plant food, and an unproductive condition has resulted in part from the removal of all vegetable matter. Nature's first effort is to produce some vegetation through whose growth and decay comes about some increase in the availability of the natural stores of fertility. A growth of weeds and briars and bushes is made the first season, and when the leaves and stalks and roots decay there is ability in the soil to produce a larger growth of vegetation the next year. Handicapped as is the abandoned soil by the greed of man, and helpless with respect to selection of the best possible plants to renew the supply of humus, the soil makes use of whatever variety of plants is possible to it and in time there is a return to better productive condition. Organic matter is the life of the soil, and the means of supplying it is the vital consideration after we have been assured of drainage and freedom from acidity.

STABLE MANURE

There is a limit to the amount of stable manure that may be made, because there is a limit to the

amount of soil products that should be furnished the human race in the form of animal products. The man who advises that all of the soil products of a farm be fed to animals, and that other feeding stuffs be purchased to make good any loss of fertility resulting from feeding and sale of live-stock, has no solution of the soil-fertility problem for the world. The human race must be supplied with other food than meat and milk, and the scheme of creation must have provided for the maintenance of soil fertility, while land furnished bread and vegetables and fruit to those who would not be farmers.

If there were an abundance of manure on all farms, the factor of organic matter in soils would need little consideration. When the manure rotted in the soil, it would improve the texture of the ground, assist in holding moisture and add plant food. But there is not enough manure to keep all the land supplied with organic matter, and dependence must be placed upon plants. We may get the material from their roots and stubble, as is usual in the case of the clovers and grasses, or from the entire plant. When the supply of manure is light, it pays best to use it to grow a heavy sod for plowing down. It can be made to supply more organic matter indirectly than it does directly. The owner of thin land who has a limited supply of manure should accept the thought that in his case the chief function of manure is to produce heavy sods which will supply vegetable matter. In his case enough of the farm supply of manure will be kept in the surface soil to furnish the most favorable conditions to young clover and grass plants when starting life. He will

plow manure deeply only after he has used a sufficient part of the farm supply as a top-dressing to insure sods.

CLOVERS

Immense importance attaches to the care and use of the manure now made. Present wastes are enormous. The supplies, however, should be supplemented by the legumes. There would hardly be a limit to the supply of organic matter from the clovers if we would meet the conditions for successful clover growing. On two-thirds of the land from the Mississippi river to the seaboard there has been a tendency to accept the idea that the clovers cannot be made to grow successfully.

In the northern states the varieties in common use are medium red, mammoth and alsike. They have been failing more and more, and land has grown deficient in organic matter and less productive. There are limited areas in which disease has caused failure, but in the vast majority of cases the inability to grow clover can be overcome. Drained land, made sweet with lime and given proper applications of fertilizer, can be brought to the production of heavy clover sods. Some who read this will doubt the statement, but within the last few years the certainty of it has been established by thousands of men on all kinds of soils. We can get the clover, and it does not pay to doubt the fact.

CHOICE OF VARIETY

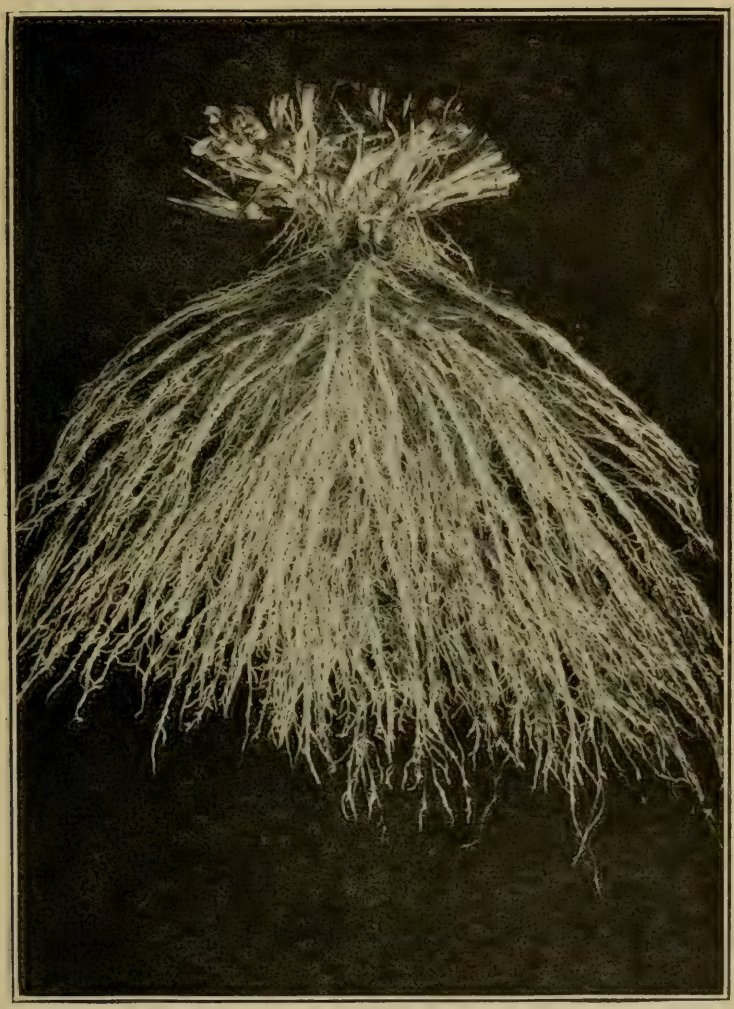
Medium red clover is a great soil builder when given a chance. It produces two crops and we can

harvest one of the two without any great injury to the soil. This may be the first crop, the second crop being plowed down. Or, we may clip the first crop, making a rich mulch, and then take off a crop of seed. When we take both crops we rob the land of organic matter unless manure comes back to it. Medium red clover also makes a big growth of roots. When a soil is not water-logged, and has been sweetened with lime, medium red has no superior in ability to build up fertility.

Where drainage is less good, and where there is some deficiency in lime, the alsike is surer. It does not equal medium red or the mammoth as a soil builder, nor does it make as much hay per acre, but it is excellent, nevertheless, and a good plan is to mix alsike and red when seeding doubtful ground. The alsike seed is small, and a mixture of one bushel of alsike to five bushels of medium red is good.

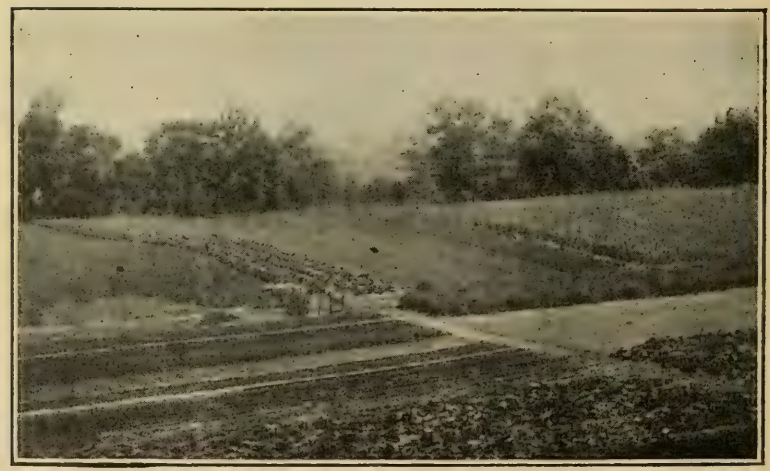
The mammoth makes only one crop. It makes coarse hay, and falls badly when seeded alone. It is a good mixture with timothy, ripening later than the medium red. The latter is the better for fertility if its second crop is left on the ground.

It would be great if crimson clover could be grown throughout the northern states. It is a winter annual, like wheat. Crimson clover can not be sown with success in the spring. The outcome would be much as in the case of winter wheat sown in the spring. If it were a hardy plant, our northern states would have the best possible winter cover crop. If people inoculated the soil for it, as they do for alfalfa,



The Large Roots of an Alsike Clover Plant

Fruit and Truck Farm Kept in a High State of Fertility



A Market-Garden on Soil That Has Been Made Rich

the day would come when much larger areas in the North would grow this clover with success.

GRASS SODS

The grasses can furnish a large amount of organic matter to land, and would be soil builders if used aright. The chief trouble is that we do not fertilize grass sods so that they will be heavy, and do not plow them down when heavy. We use them to skin the soil rather than to build it up. A heavy grass sod, turned under with some aftermath, adds largely to the soil's supply of vegetable matter, and therefore to productive power. We are learning that it pays better to fertilize a sod than to fertilize the crop following the grass. The investment makes double returns.

OTHER SOURCES OF ORGANIC MATTER

When land is not growing a crop to be harvested, it should be producing organic matter for itself. Soils produce plants on account of their hunger for vegetable matter that may rot and thereby increase their productivity. A part of that which the soil produces belongs to it by natural right, and when any man's scheme of farming provides for the removal of a greater part of the soil's production than rightfully belongs to him, the land is on the road toward infertility. Many of our best farmers find it possible to give to the land its share of that which is produced by making free use of catch crops. They may be grown after the removal of the regular crop in the rotation, or they may be grown with some of

these crops. Frequently they may take the place of some crop whose failure was inevitable on account of conditions that could not be controlled. In warm latitudes, the southern field pea and crimson clover are peculiarly valuable because they add large stores of nitrogen while supplying organic matter. Farther north, the Soy bean takes the place occupied by the southern field pea in the south. It will thrive in any good corn soil. Winter vetch is another valuable legume. Rye is the surest winter cover crop for northern latitudes and has considerable value. Any plant that adds organic matter to the ground adds productive power, provided there is lime in the soil to unite with the acids produced by the rotting plant.

CHAPTER V

THE FOURTH ESSENTIAL

AVAILABLE PLANT FOOD

When we consider our soil-fertility problem simply and broadly, there are those who accept the statement that drainage, soil sweetness and organic matter are essentials, but they believe that these three are the only essentials; and that I am all wrong in naming a fourth—commercial fertilizers. Again there are those who accept the fourth, but don't see anything simple about proper selection of commercial fertilizers, while they do know how to drain, to sweeten a soil, and to work out the best way of getting plenty of organic matter.

THE NEED

The first class may have a soil well filled with available fertility. There is such land. The day will come when its supply of mineral plant food will run too low for maximum production. Then will be the time to replenish it. Nature stored up great deposits for this purpose. But many farmers on naturally rich land, or land receiving stable manure, are failing to get the best yields of grain, potatoes, etc., because they do not supply some phosphoric acid and potash—especially the former. The clover and the manure supply nitrogen which makes a rank growth of stalk and leaf, but the yield of grain is not in proportion, because phosphoric acid is lacking.

WHAT TO APPLY

It is easier to find out that certain quantities of certain elements will bring some net profit than it is to learn what application will bring the most net profit. It is the best net profit that one wants, and I reckon that few ever do hit the mark exactly. But there are some broad lines between which we can work. We can make far more intelligent guesses than some of us are doing, and then we can learn by each year's experience.

UNPRODUCTIVE LAND

Most land has a lot of fertility in it that is not available. It is like ore before it is mined. It constitutes the "natural strength" of the soil. This material becomes unlocked gradually by means of good tillage and the action of rotting vegetable matter. When we undertake to improve a poor field, it usually pays to supply nitrogen, phosphoric acid and potash—a high-grade complete fertilizer—until we can get a supply of organic matter at work for us in the soil. The complete fertilizer helps to make a heavy sod for plowing down, or a growth to be plowed under. The soil is nearly helpless until the humus-making material is supplied.

When land has been hard-run, and is unproductive, it needs the three elements in a complete fertilizer, but such land, when sweetened with lime, should grow clover if the phosphoric acid and potash are supplied liberally. The clover, with some stable manure on the farm, should supply the greater part

$20,000 Improvements Paid for from Proceeds of Farm—Fertility Did It

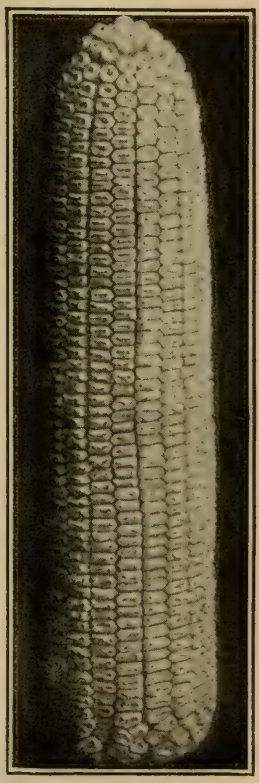
A Rich Soil Grows Big Wheat

Soy Beans Make Rich Soil

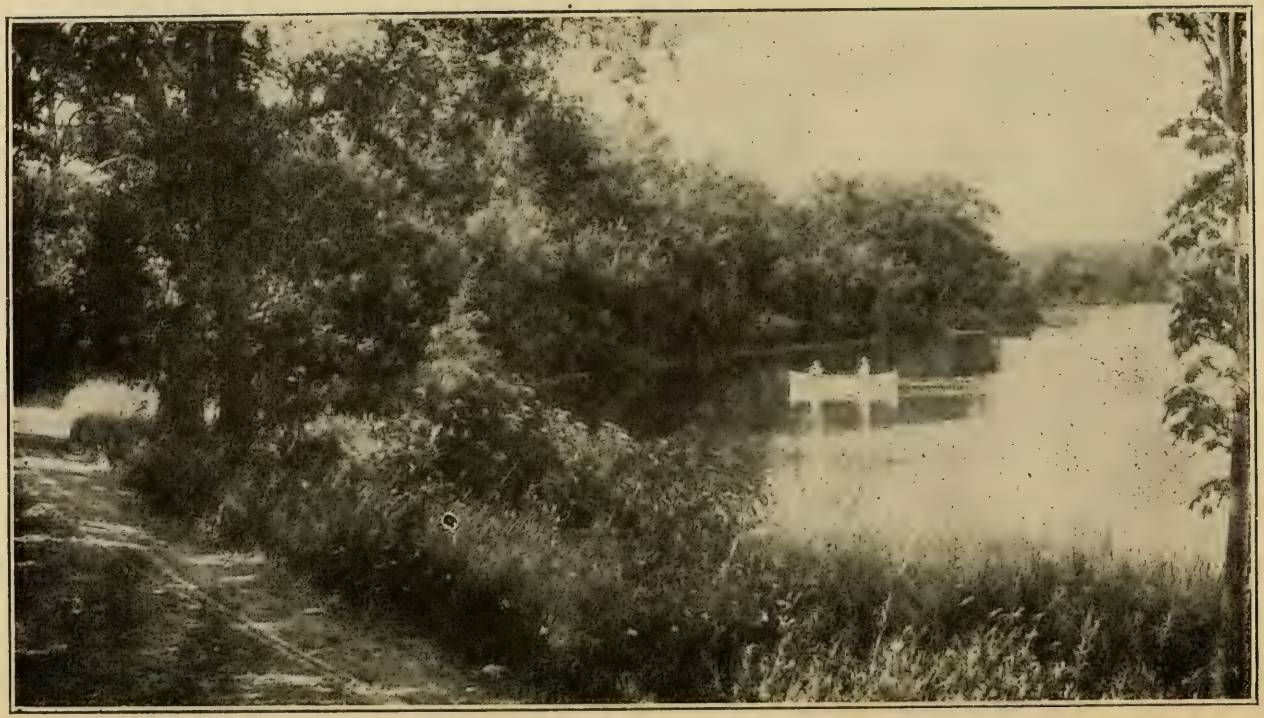
Extensive Lettuce Growing

Limestone on Sweet Clover at Ohio Experiment Station. The Large Growth is Limed

Prolific Oats



Champion Corn



The Pleasures of Life Come to Those Who Do Their Work Well

of the nitrogen for all staple crops. We can tell whether it is doing so by the appearance of the growing plants. This is simple enough. If corn makes a heavy stalk, with broad, dark leaves; if timothy grows rank; if potato vines are heavy—quit buying nitrogen. If plants are pale in color and small, buy nitrogen until the clovers and manure do supply the need. If it will not pay to feed plants according to their need, it will not pay to farm the land.

THE MINERAL ELEMENTS

We should learn from others. It is the experience of nearly all experiment stations and landowners, from the Mississippi river to the Atlantic seaboard, that phosphoric acid is the limiting element in our soils. That is to say, if a soil lacks anything phosphoric acid will be found to be deficient. Other plant food may be lacking also—probably is, if the soil is poor—but most of all is the need of phosphorus. Hence we learn to supply it, and our usual failure is to supply it liberally. The chances always are that we should use steamed bone, basic slag or acid phosphate, or a mixed fertilizer running high in phosphorus.

THE COMPLETE FERTILIZER

There are immense beds of material containing phosphorus, and there is a nearly universal hunger for that element in our soils. When we supply enough, together with potash where needed, to produce good clover, we have land brought up to a good state of

productiveness. We get crops yielding profit. After the marked deficiency has been met in this way, further increase in yield of cereals, grasses and most vegetables comes from the use of a fertilizer supplying all three elements. First use freely the carriers of phosphorus on land that will grow clover well, and let the organic matter help to free plant food. Then, usually on such land a complete fertilizer helps to still greater profit.

Thin land is helpless. We supply everything to get clover started. Later, with the clover, we depend heavily upon phosphorus for profitable, productive condition. Then, with the chief hunger of the soil met, when we go after increased yields, we find the complete fertilizer pays. In some soils the need of potash is as marked as that of phosphorus.

RATIONAL FARMING

Our country is comparatively new. It was cleared and cropped. The need of drainage in many sections has increased as the subsoil became packed and the top soil lost its humus. The lime has washed out or been used up. The organic matter has been consumed, and the stores of soil strength have been locked up. The steps toward improvement are not difficult to understand. We have learned much about methods of draining. We have learned the imperative need of lime, and what and how to apply to make a soil sweet and friendly to clover. We have learned to plan so that the soil's natural share of vegetable matter may go back to it in sods, catch crops and manure. We have learned something

about supplying a soil's hunger for mineral elements.

We have an immense deal yet to learn about methods, so as to meet the land's need, and at the same time get the most net profit, but we know the general direction of the road we must travel. The amount of stuff we should feed on the farm, the rotation and kind of crops, the amount of tillage, the place to use fertilizers and the amount—an endless mass of things puzzle every thinking farmer, and will continue to puzzle us because circumstances vary; but we do find the fundamental principles simple, and know what we are trying to do. The farming of the next fifty years will be far more intelligent than that of the past, and land will grow better and not worse.

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